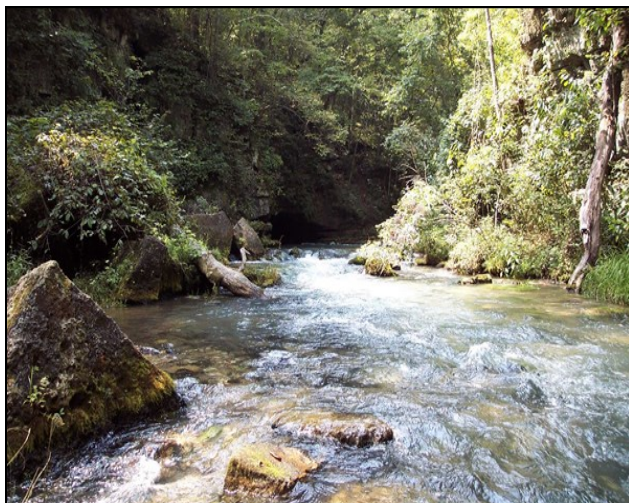


Groundwater: A Hidden Resource

Hidden beneath the varied landscapes of Missouri is one of the state's most treasured and important natural resources, groundwater. Groundwater is water found beneath the Earth's surface. It is ultimately supplied and replenished by precipitation that finds its way underground where it moves through and is stored in **bedrock**, sand, and other materials. Groundwater eventually resurfaces naturally in **artesian wells** and **springs** or can be pumped from wells for use by homes, industries and agriculture. Rock layers that can store and release significant quantities of water are called **aquifers**. Fortunately, Missouri has many aquifers.



Groundwater resurfacing from a spring

All of the **potable** groundwater in storage in Missouri originated as and is recharged by relatively local precipitation. During years of abundant precipitation, the volume of groundwater in storage generally increases and groundwater levels in shallow aquifers rise. During times of prolonged **drought**, water levels decline, and the total amount of water in storage decreases.

Although yearly precipitation in Missouri typically ranges from 35 inches to 48 inches¹, only a fraction of this becomes either surface water runoff or groundwater recharge. Much of the precipitation is lost back into the atmosphere through evaporation, or is used by plants through **transpiration**. Combined, these losses are called **evapotranspiration**, and on the average they range from about 26 inches in northwestern Missouri to about 30 inches in southeastern Missouri².

Generally, evapotranspiration rates are highest during hot summer months and least during winter and spring. However, before evapotranspiration can occur the soil must contain moisture. During droughts, evapotranspiration may actually be low because of the lack of soil moisture.

Statewide groundwater storage estimates show that aquifers in Missouri contain slightly more than 500 trillion gallons of usable quality groundwater. This is enough water to cover the state to a depth of over 34 feet, or supply each of its nearly 6.1 million residents 100 gallons of water per day for nearly 2,250 years. It is equivalent to the volume of rainfall that Missouri normally receives in nearly an 11-year period³.

Managing Our Groundwater

The above comparisons are useful for visualizing the magnitude of this resource, but they do not reflect how groundwater should be managed. For example, a per capita water use of 100 gallons per person per day⁴ is commonly assumed when estimating water use for small towns, public water supply districts, and even private water supplies. However this is a small fraction of the total amount of water needed for our society.

Tremendous volumes of water are used for industrial and commercial purposes, agricultural irrigation, power production and other purposes. It must be remembered that in order to remain a renewable resource, the net use of groundwater must not exceed its net recharge. The volume of groundwater that Missouri has available is so staggering that it is difficult to imagine how such a resource could ever be depleted.



Caves are the result of groundwater slowly dissolving limestone bedrock.

In a few areas of the state it would be extremely difficult to use all of the available groundwater. However, groundwater resources are not evenly distributed. Neither is groundwater use. Production from a particular aquifer may be minimal throughout most of a county, but very high in a few square-mile area due to municipal, industrial or agricultural needs. It is quite possible to overuse an aquifer in one area, while the same aquifer a few miles away is essentially unused.

If groundwater resources were evenly distributed across the state, then each square mile of Missouri would contain about 7.17 billion gallons of water beneath it. Unfortunately, this is not the case. Average groundwater availability in Missouri north of the Missouri River is only about 2.8 billion gallons per square mile, while that of the southern part of is much higher, about 9.5 billion gallons per square mile⁵. Locally, groundwater

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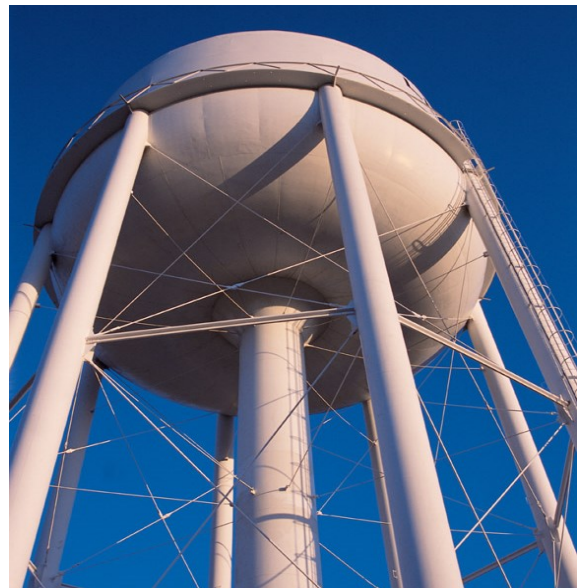
Agricultural irrigation

storage in northern Missouri can be much less than the average. Thus, a resource that many may take for granted in the southern part of the state is considered a precious commodity in the north.

Unlike many western states where groundwater recharge rates are so low that groundwater is not replenished, most Missouri aquifers receive considerable recharge in most years. With proper management and protection, Missouri's groundwater resources can continue to provide high-quality water to meet many of the state's domestic, municipal, industrial, agricultural, and recreational needs. Avoiding aquifer over-use and protecting groundwater from contaminants are two ways to best ensure its continued availability for future use.

Groundwater Depletion

The U.S. Geological Survey compares the water stored in the ground to money kept in a bank account. If the money is withdrawn at a faster rate than new money is deposited, there will eventually be account-supply problems. Pumping water out of the ground at a faster rate than it is replenished over the long-term causes similar problems. Some of the negative effects of groundwater depletion are:



Water towers store water for communities

- Excessive pumping can lower the groundwater table to the point that wells can no longer reach groundwater.
- As the water table lowers, the water must be pumped farther to reach the surface, using more energy and increasing costs.
- When groundwater is overused the lakes, streams, and rivers connected to groundwater can also have their supply diminished.
- The overuse of groundwater can bring about loss of support below ground that causes the soil to collapse, compact, and drop; referred to as **land subsidence**.

How DNR Helps: Groundwater Protection

Infiltrating water may bring contaminants down to the water table or aquifer. The Department of Natural Resources plays an important role in the protection of Missouri's groundwater resources. Following are just some of the ways that the department works to protect this valuable resource.



Even surface water supplies, like lakes and rivers, are impacted when groundwater is

New well construction rules have been designed to ensure that contamination from the surface is not entering the subsurface from an improperly constructed well. The rules establish minimum specifications for well construction.

The Soil and Water Conservation Program has established cost share practices that assist Missouri farmers with protecting sinkholes on their property from sediments, chemicals, pesticides or organic matter entering the underground karst system.

The Missouri Pesticide Collection Program provides free collection events for farmers and households throughout the state of Missouri to properly dispose of unwanted pesticides. From 2012 to 2016, the Missouri Pesticide Collection Program has conducted 32 events, collecting more than 252,800 pounds of waste pesticide from 924 participants.

The Missouri Geological Survey Program has operated a water tracing laboratory dedicated to conducting water traces and related research. Groundwater investigations, cave exploration, well installation methods, engineering aspects related to leaking dams, and the determination of properly working septic tanks are a few instances when water traces are performed today.

The Underground Storage Tank rule is designed specifically to protect the quality of groundwater in the state as well as to protect human health and the overall quality of the environment. Department staff provide oversight and technical assistance regarding tank inspections, installation and removal of underground storage tanks and the permanent closure of out of use underground storage tanks.



The Missouri Water Tracing Laboratory performs a number of traces each year.

References

Statistics about groundwater have been taken from the following publication:

Miller, Don E., and Vandike, James E., 1997, Missouri State Water Plan Series Volume II, Groundwater Resources of Missouri, Missouri Department of Natural Resources' Division of Geology and Land Survey, Water Resources Report No. 46, 210 p.

1. See page 23
2. See page 23
3. See page 2. Original text used outdated population totals for calculations. The 2015 population of 6.1 million people was used to update the statistics.
4. See page 204
5. See page 2

Glossary of Terms

Aquifer: An underground layer of sand, gravel, or rock that holds water in pores or crevices.

Artesian well: A well where water from a confined aquifer flows up to the surface because of natural pressure.

Bedrock: Solid or fractured rock usually underlying unconsolidated geologic materials like soil, sand and gravel. Bedrock may also be exposed at the surface.

Drought: A long period of time during which there is very little or no rain, especially when prolonged; one that causes extensive damage to crops or prevents their successful growth.

Evapotranspiration: The process by which water is transferred from the land to the atmosphere by evaporation from the ocean, soil and other surfaces and by transpiration from plants.

Land subsidence: The lowering of the surface of the ground because of removal of support. Caused in karst areas by subterranean solution or the collapse of caves. Also seen in areas suffering long-term drought where dry soil compacts.

Potable: Water fit or suitable for drinking.

Spring: A natural discharge of groundwater at the land's surface.

Transpiration: The process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere.

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